

North Carolina 2012 Food Waste Generation Study

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A comprehensive report quantifying the amount of food waste generated in North Carolina by residents and commercial businesses.



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Food Waste Disposal and Generation in North Carolina

The N.C. Department of Environment and Natural Resources is engaged in a concerted effort to better understand both the quantity of food waste generated in North Carolina and the available infrastructure to divert this material from landfill disposal. This report presents an estimate for the annual tonnage of food waste generated and disposed by various actors. Though the amount of food waste in the residential and commercial sectors is similar, generation in the residential sector appears to be higher. In total, North Carolina DENR estimates that more than 1.1 million tons of food are generated in the state every year.

The results of this study are reported in three sections: residential, commercial and municipal solid waste (MSW). The method of this analysis was intended to provide detail for specific residential and commercial generation categories and then to use the MSW calculation to validate or cross-check how those categories add up to a total food waste estimate. The commercial waste stream section of the report also contains detailed estimates for individual waste generators in the retail sector. Supermarkets represent the largest single generation source of food waste, with each store generating an estimated 106 tons of food waste annually. Supermarkets represent a clear “first target” for diversion initiatives and will be a critical factor in the recovery of North Carolina’s food waste.

Table 1: Summary of Residential, Commercial and MSW food waste characterization

	Lower bound	Upper bound	Mean	Std Dev
Residential	556,014	847,075	673,362	153,408
Commercial	357,169	849,504	569,343	207,220
MSW	1,029,149	1,254,031	1,112,308	114,346

While residential and commercial tonnage represent the majority of non-industrial and agricultural food waste in the state, the mean estimate for MSW food waste in this report is not be exactly equal to the sum of the residential and commercial sectors. The EPA provides a definition for MSW but most states continue to have their own unique understanding of what actually constitutes MSW, based on local circumstances. In North Carolina, for example, construction and demolition debris (C&D) waste is often factored in as a component of MSW because C&D landfills are technically a subset of MSW landfills, and because much of C&D waste is still disposed alongside traditional residential and commercial waste. This makes it impossible to assume that residential and commercial streams are clean estimates of the total waste available. This study therefore calculates MSW as an independent estimate.

This report provides average estimates using three different methods of quantifying food waste: 1) share of population using state waste characterization reports, 2) share of generators using directed studies, and 3) EPA-provided percentages. It is important to note that state characterization reports measure the disposal rates, rather than the source generation rates of waste, and can be affected by local infrastructure and laws. Generation studies address some of this bias.

Residential Waste Stream

Residential food waste is generated in private homes and other living spaces. To obtain an estimate for residential food waste in North Carolina, data was collected from seven state waste characterization reports. Additional estimates were found using the EPA-Food-Waste-Biogas-Economic-Model (2007), and “Using Contemporary Archaeology and Applied Anthropology to Understand Food Loss in the American Food System (data from 2002).” The final estimates for residential food waste generated by these methods were **556,477**; **616,533**; and **847,075** tons per year respectively.

- I. State and county waste characterization studies vary in their definition of the residential sector. The mode of waste delivery - curbside collection vs. self-hauling - may also affect estimates. The tonnage of residential food waste was determined for each state, based on sources provided in the bibliography. Next, the U.S. Census Bureau’s population data was used to estimate North Carolina’s residential food waste disposal. For example, if Nebraska was .59 percent of the population of the United States in 2009 and if it disposed of 106,303 tons of food waste, then extrapolating Nebraska’s food waste estimate to the nation as a whole ($106,303 / .0059$) would yield about 18,017,458 tons. If North Carolina was just more than 3 percent of the population, then $18,017,458 * 3.1$ percent = 555,049 tons of residential food waste was disposed in North Carolina in 2009. The table below shows the complete results for calculations using waste characterizations for Nebraska, Oregon, Connecticut, Wisconsin, Washington, Illinois, California and Georgia.

Table 2: Residential food waste characterization studies by states

Year (Titled or Published)	State	Percent of U.S. population in year of study	Residential Food Tonnage	Estimated N.C. Annual Residential Food Waste by percent of population*
2009	Nebraska	0.59%	106,303	555,049
2009	Oregon	1.25%	186,549	457,437
2010	Connecticut	1.16%	183,112	488,532
2009	Wisconsin	1.84%	251,423	417,094
2009	Washington	2.17%	414,879	584,006
2009	Illinois	4.21%	919,050	667,795
2008	California	12.02%	3,034,040	766,980
2005	Georgia	3.06%	538,012	514,924

Mean Residential Estimate	556,477
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- II. A second estimate of residential food waste is provided by the EPA-Food-Waste-Biogas-Economic-Model. This pre-packaged model uses data from the 2007 USDA food availability system. Plugging 3,626,179 households for North Carolina (U. S. Census Bureau, American Community Survey, 5-Year Estimates 2006-2010) into the model yields a food waste estimate of **616,533 annual tons**.
- III. A per-household estimate for residential food waste is also provided by Dr. Timothy Jones, based on 2002 data. As part of the U.S. Department of Agriculture’s Food Loss Project, Jones estimated that the average American household throws out 1.28 pounds of food per day (Timothy W. Jones, pg 2).

His data was collected by hand-sorting refuse and comparing food purchased vs. food used. While his data is older than the waste characterization studies above, it provides a national perspective and data collection closer to the source of generation.

Table 3: Food Waste Generation by Household using the USDA Food Loss Project Analysis

Tons per household per year	Number of Households in North Carolina, American Community Survey 2006-2010	Total Tons Per Year
0.23	3,626,179	847,075

Summary

Appendix A provides data from one additional study carried out in the United Kingdom by the Waste and Resources Action Programme, or WRAP, a nongovernmental organization dedicated to waste diversion. WRAP’s study includes liquid waste such as soda and other sink-disposed residuals in its food waste estimate, disqualifying it as a data point for the mean estimate in this study. WRAP’s study yields an extrapolated estimate for North Carolina of **1,319,069 tons of annual generation**. Even if one accounts for the liquid waste, this is still a very high number. Given WRAP’s reputation as a leader in the food waste diversion studies, it remains an interesting point for those interested in total waste characterization and suggests that the estimates provided in this report are conservative.

Using three different data approaches, this study finds a range of possibilities for food waste generation in North Carolina. State-commissioned waste characterization studies, typically carried out far from the source of generation, represent the minimum estimate of residential food waste availability. Together with the second and third estimates, based on data recorded at the source of generation, this study finds that each household in North Carolina generates more than seven pounds of food waste every week, with an average total generation of 673,362 tons annually.

Commercial Waste Stream

Commercial waste is defined as waste generated by trades and businesses separate from the household, agriculture and industrial sectors. However, commercial waste estimates are often combined into a category with institutional and industrial sources, captured as “ICI” materials. Part 1 of this section generates an estimate for commercial and ICI waste disposal using characterization studies, data produced by the Cascadia Group for the California EPA, Dr. Jones’ report, and data produced by Draper/Lennon Inc. for the Massachusetts Department of Environment Protection. The final estimates for residential food waste generated by these methods were **496,613; 574,084; 849,504; and 357,169** tons per year respectively. Part 2 provides a more detailed estimate on waste produced by specific commercial sectors and reports on primary data gathered from North Carolina.

Part 1 – Overall Generation

I. As with residential waste, state and county waste characterization studies vary in their definition of the commercial sector. In fact, limited data is available on isolated commercial generation and disposal through characterization studies. Many of the state studies use the ICI characterization. Unless otherwise noted in the table below, all studies are assumed to measure ICI.

IV. Once the tonnage of commercial or ICI food waste was determined for each state, the U.S. Census Bureau’s population data was used to estimate North Carolina’s disposal. For example, if Nebraska was .59 percent of the population of the United States in 2009 and disposed of about 78,751 tons of commercial food waste, then $78,751 / .0059$ would yield a national total of around 13,451,506 tons in 2009. North Carolina’s per capita share of the national total would then be $13,451,506 * 3.1$ percent, producing 411,193 tons of commercial food waste disposed of in the state in 2009. The table below shows the results for calculations using waste characterizations for Nebraska, Oregon, Connecticut, Wisconsin, Washington, Illinois, California and Georgia.

Table 4: ICI food waste characterization studies by states

Year (Titled or Published)	State	Percent of U.S. population in year of study	ICI/Commercial Food Tonnage	Estimated N.C. Annual Commercial and ICI Food Waste by percent of population
2009	Nebraska*	0.59%	78,751	411,193
2009	Oregon*	1.25%	81,996	201,062
2010	Connecticut	1.16%	138,369	369,160
2009	Wisconsin	1.84%	251,423	397,390
2009	Washington	2.17%	485,306	683,143
2009	Illinois	4.21%	919,050	667,795
2008	California	12.02%	3,032,805	766,668
2005	Georgia	3.06%	497,862	476,497

*These studies focus solely on commercial retail as opposed to ICI generation and disposal.

Mean ICI Estimate	496,613
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II. The Cascadia Consulting Group’s report, “Targeted Statewide [California] Waste Characterization Study: Waste Disposal and Diversion Findings for Selected Industry Groups (2006),” used in-person surveys and hand-sorting to determine the amount of waste generated (disposed and diverted) by retailers. Cascadia quantified its results on a per-employee-per-year scale. While California has a larger infrastructure for commercial food waste diversion than North Carolina, the Cascadia report’s calculation of generation as opposed to disposal should correct for this. Unlike the waste characterization studies, this study is limited to food retailers.

Table 5: Food Waste Generation by Retailer, California

Store Type	Tons generated per employee per year	Number of paid employees in North Carolina (2010 County Business Patterns)	Estimated Annual Tons for North Carolina
Fast Food (NAICS 722211)	1.2	139,121	173,463
Food and Beverage Stores (NAICS 445)	2.3	71,157	164,560
Full Service Restaurant (NAICS 722110)	1.7	139,175	236,062

Total	574,084
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III. A per-retailer estimate for commercial food waste is also provided by Dr. Timothy Jones based on 2002 data. As part of the USDA Food Loss Project, Jones estimated the amount of daily waste generated by fast-food restaurants, convenience stores, full-service restaurants and supermarkets. His data was collected using hand-sorting and measurements of food purchased by the retailers against food sold to customers. While his data is older than the waste characterization studies above, it provides a national perspective and data collection closer to the source of generation. These factors may also lead to a higher estimate.

Interestingly, Jones attributes the large amount of food lost by fast-food restaurants to storage and delivery practices. He explains that fast-food restaurants have small storage areas and face irregular customer demand, but they order food two days in advance. This results in high quantities of discarded meat-based products. Subsequent discussions with national industry professionals throw a measure of doubt on this explanation.

Table 6: Food Waste Generation by Retailer, Jones

Store Type	Total Tons Lost per Store per Day (including grain, meat, fruit, vegetables)	Number of Stores in North Carolina (2010 County Business Patterns)	Estimated Daily Food Waste	Estimated Annual Food Waste Tons
Fast-Food (NAICS 7222)	0.21	8,155	1,706	622,729
Convenience (NAICS 44512)	0.03	751	20	7,226
Full-Service Restaurant (NAICS 7221)	0.07	7,126	492	179,715
Supermarket (NAICS 44511)	0.06	1,807	109	39,834

Total	849,504
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More recently, Dr. Jean C Buzby, et.al., provided the USDA with more specific estimates for food loss in the supermarket industry. The table below shows the findings. Buzby’s final estimate, based only on fresh food wasted, far surpasses Jones’ projected supermarket losses. While Buzby’s estimate is not included in our macro projection, due to its specificity, it provides a good example of the variability in generation estimates.

Table 7: Food Waste Generation by Supermarkets, Buzby et.al

	Retail Weight from ERS Loss-Adjusted Food Availability data for 2005.	Pounds available at the consumer level (PG Estimate)	Annual Pounds Lost per capita	Annual Loss in North Carolina (Tons)
Fruit	119	106	14	64,841
Vegetables	180	163	17	82,959
Meat, Poultry, Seafood	195	186	9	41,956
Total	495	455	40	189,756

IV. The 2003 study, “Identification, Characterization, and Mapping of Food Waste and Food Waste Generators in Massachusetts,” includes food retailers, and other sources such as resorts, nursing homes and colleges. The study produces its estimates based on generator surveys and literature reviews. Although the study, prepared for the Massachusetts Department of Environmental Protection (MDEP), includes a broad list of generators, it strictly limits the size and make-up of each generator studied. When North Carolina retailers are limited in a similar manner, the result is a small population of overall generators. The projected tonnage for North Carolina based on the MDEP findings is therefore on a very low end at **357,169 tons/year**. Changes in the census bureau’s coding after the period of the MDEP study may cause some discrepancy in the estimates; however it is unclear what effect this might have, if any. More likely, the disparity between estimates simply demonstrates the diverse findings of food waste studies and the need for more research into food waste generation.

The MDEP study is used in the EPA-Food-Waste-Biogas-Economic-Model, also cited in the residential waste estimates (Section 1). While the EPA does not mention that any limits should be placed on the size of the generator, DENR feels that this factor contributes to food waste generation in important ways and it is therefore necessary to account for this when the original document clearly references such methods. The limitations on generators and data sources can be found, in full, in the bibliography (Commercial Waste, IV).

Table 8: Food Waste Generation by Retailer and Service Provider, Massachusetts

Generator Category	Number of N.C. Establishments (2010 County Business Patterns)	Generation Per Establishment (short tons/yr)	Total Projected N.C. Generation (short tons/yr)	Percent of total generation in NORTH CAROLINA	Percent of total generation in MDEP study
Hospitals (NAICS 622)	153	115	17,653	5%	4%
Nursing Homes and Related	648	54	35,032	10%	8%
Colleges, Universities (NAICS 6113)	110	242	26,637	7%	7%
Boarding Schools	38	48	1,815	0.5%	0.3%
Correctional Institutions*	66	104	6,841	2%	1%
Resorts / Conference Facilities	55	61	3,374	1%	2%
Supermarkets (NAICS 44511 with 10 or more employees)	408	222	90,604	25%	27%
Convenience Stores (NAICS 44512 with 10 or more employees)	164	43	7,022	2%	2%
Restaurants (NAICS 7221 and 7222 with 10 or more employees)	3,320	51	168,191	47%	49%

Total	357,169
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Food manufacturers and wholesale distributors surveyed in Massachusetts also generated a large amount of waste. Together these sectors account for half of estimated food waste in the MDEP report. Unfortunately, DENR is unable to study these sectors closely so they have been removed from the data analysis. Historically, this sector also has had strong internal systems in place for diverting food waste, so it is a low priority target for new collection programs. However, with 358 applicable manufacturers in North Carolina (NAICS 311 with 5 or more employees, 2010 County Business Patterns), producing on average 656 tons/establishment/year, these sectors are worth consideration for future research and as a possible source of local material in the case of a growing collection program.

Part 2 – Waste Generation Comparison by Type of Generator

I. The retail food industry, including restaurants and supermarkets, is a major generator of food waste and a visible target for segregated food waste collection. Already, a handful of food waste composters in the state of North Carolina are working with supermarkets to divert their organic material. A state-specific estimate provided by a North Carolina hauler collecting segregated food waste from a major grocery chain places the state total for supermarket and convenience store waste at 273,902 tons. This number is the largest estimate for supermarket and convenience store waste generation available in this report, again suggesting that the findings we present may be considered a conservative estimate of total waste.

Table 9: Food Waste Generation by Grocers in North Carolina

	Weekly Tons per Store	Annual Tons per Store	Number of Stores in N.C.	Annual State Total
Large Store (Supermarket)	2.25	117	1,807	211,419
Small Store (Convenience)	1.6	83	751	62,483
			Total	273,902

II. Targeting early adopters and major generators will be critical for the planned growth of food waste infrastructure in North Carolina. Comparing the estimates in the studies covered by this report, we see that the number of establishments in the restaurant industry make it the largest annual generator of food waste. However, although smaller in terms of overall establishments, supermarkets and grocery stores generate more waste on a per-store basis.

Table 10: Food Waste Generation by Sector

	CASCADIA (2006)	MDEP (2003)*	Jones (2002)	Buzby (2009)	North Carolina (2012)	Total Annual Tonnage (Average)
Fast Food (NAICS 7222)	173,463	168,191	622,729			321,461
Restaurants (NAICS 7221)	236,062	Included Above	179,715			207,889**
Supermarkets (NAICS 44511)	164,560	90,604	39,834	189,756	211,419	139,235
Convenience Stores (NAICS 44512)	Included above	7,022	7,226		62,483	25,577

Table 11: Food Waste Generation by Individual Store

	CASCADIA (2006)	MDEP (2003)*	Jones (2002)	Buzby (2009)	North Carolina (2012)	Per Store Annual Tonnage (Average)
Fast-Food (NAICS 7222)	21	51	76			50
Restaurants (NAICS 7221)	33	Included above	25			29
Supermarkets (NAICS 44511)	64	222	22	105	117	106
Convenience Stores (NAICS 44512)	Included above	43	10		83	45

*Massachusetts' estimates do not include stores with less than 10 employees.

The tables above demonstrate the wide span of estimates for food waste generation in the commercial sector. This variability makes the overall quantification of waste generation less precise than the projection for the residential sector. Counties will find it helpful to reference the individual sector estimates in this section when considering food waste diversion programs.

III. The final section provides data from Orange County, a leader in food waste diversion in North Carolina. Thanks to the excellent record-keeping in its voluntary commercial waste collection program, it is possible to calculate the local per-store average for diverted food waste entering the municipal waste stream. While only limited generalizations can be made from this data, it provides a useful point of comparison to national studies. In fact, Orange County's firsthand experience corresponds closely with the per-store and sector estimates above.

Table 12: Waste Generation per Type per Store (tons), Orange County

	Number of Establishments	Average Monthly Tonnage 08-09	Average Monthly Tonnage 09-10	Average Monthly Tonnage 10-11	Average Monthly Tonnage 11-12	Four-Year Average per Store per Year	Projected State Tonnage
Restaurants (NAICS 7221)	12	2	3	3	3	32	225,393
All college	5 (one missing in 08)	10	8	11	11	120	
Supermarkets (NAICS 44511)	3	9	8	8	8	101	181,942
Grocery (NAICS 44512)	5 (all Weaver St.)	4	4	4	4	48	35,932
Residences and hotels	3 (one missing in 08)	4	4	5	5	54	
Schools	3	n/a	n/a	n/a	0.15	n/a	
Conference Center	1	4	3	5	5	52	
Hospital	1	12	15	19	17	188	
Other	3 (inconsistent)	n/a	n/a	n/a	n/a	n/a	

Summary of Separate Residential and Commercial Food Waste Estimates

Individual counties are encouraged to pay close attention to the producer breakdown provided in this section. In addition, this study averages the estimates in Part 2 (**496,613; 574,084; 849,504; and 357,169** tons per year) to estimate 569,343 tons per year for total commercial food waste generation for the state of North Carolina. Combined with the residential estimate, this study projects a total of 1,242,704 tons of annual food waste, or about 3,405 tons per day, generated across North Carolina.

Municipal Solid Waste Stream

Attempting to find a standard definition of the municipal waste sector is more challenging than the residential and commercial sectors because local understandings of MSW are highly variable and, at times, ambiguous. However, most food waste in the municipal stream is generated by food industry and retail or residential consumers. For the most part, MSW estimates will include all of these generators. This section takes three approaches to estimating MSW food waste: the first uses the information from characterization studies, as above; the second relies on the EPA’s estimate of food waste content in MSW; and the third combines the estimates from the sections above to derive a total waste estimate based on the analysis of residential and commercial waste. The final estimates for MSW food waste generated by these methods were **1,065,072; 1,105,691; and 1,242,704** tons per year respectively.

V. State characterization studies for waste disposal estimate MSW quantities in a variety of different ways. For example, Nebraska uses the EPA’s 2008 estimates to determine its total MSW, while Connecticut sums the state reported totals for ICI and residential waste. Once the tonnage of MSW was determined for each state, the U.S. Census Bureau’s population data was used to estimate North Carolina’s disposal. For example, if Nebraska is .59 percent of the population of the United States in 2009 and disposed of about 223,309 tons of MSW food waste, then $223,309 / .0059$ would yield a national total of around 38,159,079 tons in 2009. North Carolina’s per capita share of the national total would then be $38,159,079 * 3.1$ percent, producing 1,165,988 tons of MSW food waste disposed of in North Carolina in 2009. . The table below shows the complete results for calculations using waste characterizations for Nebraska, Oregon, Connecticut, Washington, Illinois, California, Missouri and Georgia, as well as Wake and Orange Counties, North Carolina.

Table 13: MSW food waste characterization studies by states

Year (Titled or Published)	State	Percent of U.S. population	MSW Food Ton	Estimated N.C. MSW Food Waste by percent of national population
2009	Nebraska	0.59%	223,309	1,165,988
2009	Oregon	1.25%	441,118	1,081,665
2010	Connecticut	1.16%	321,481	857,692
2009	Washington	2.17%	916,320	1,289,862
2009	Illinois	4.21%	1,838,100	1,335,589
2008	California	12.02%	6,158,120	1,556,721

2008	Missouri	1.96%	639,002	992,051
2005	Georgia	3.06%	1,204,505	1,152,816
	N.C. Counties	Percent of N.C. population		
2011	Wake	9.63%	95,703	993,942
2011	Orange	1.41%	8,541	607,556*

*If we take into account food waste diverted through Orange County's food waste collection, the projection for North Carolina's total food waste increases from 607,556 to 754,027. The diverted food is not included in our mean estimate in order to keep our processes uniform across all states and counties.

Mean MSW Estimate	1,065,072
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I. Every year the EPA releases estimates for national waste composition. According to the 2010 EPA fact sheet, 13.9 percent of MSW is food waste. The state of North Carolina reports 9,467,045 tons of solid waste disposed of in landfills in FY 2010-11. DENR estimates that 2,063,093 tons of this total is C&D waste, which would not be included in the EPA's definition of MSW. Therefore, using 7,403,952 tons as the total amount of North Carolina MSW, this study estimates that about **1,029,149** tons of food waste can be found in the state's municipal solid waste stream.

II. We might expect that the estimated sums from residential and commercial waste in this report would be lower than the state waste characterization studies and the EPA's general estimate. The residential estimate only applies to at-home waste production, leaving out any food waste generation that might occur in parks, on the street, in the office or at other outside events. Meanwhile the commercial estimate focuses mainly on food retailers without completely factoring in manufacturers and smaller generators such as hospitals, cafeterias, and offices. However, at 673,362 and 569,343 residential and commercial waste adds up to a slightly higher total of **1,242,704** tons of MSW food waste annually. One reason for this discrepancy might be that while MSW characterizations include all the sectors missing in residential and commercial studies, they exclude any waste that is already being diverted. By using studies that measure both at source generation as well as disposal, we hope to get closer to the true amount of waste generated in North Carolina.

Conclusion and Recommendations

This report draws on a number of different forms of reporting and analysis to build a mean estimate and scale of food waste generation in North Carolina. Based on the analyses above, a conservative estimate of total food waste in the North Carolina waste stream is 1.1 million annual tons. The commercial sector generates a smaller amount of waste than the residential sector, at 569,343 and 673,362 tons respectively. This report uses waste characterization studies as well as generation studies that measure material prior to diversion. With this variety of data sources, we can more nearly pinpoint the true amount of food waste in the state of North Carolina, where infrastructure for capturing commercial and residential food waste is still in its infancy.

Table 14: Summary of Residential, Commercial, and MSW food waste characterization

	Lower bound	Upper bound	Mean	Std Dev
Residential	556,014	847,075	673,362	153,408
Commercial	357,169	849,504	569,343	207,220
MSW	1,029,149	1,254,031	1,112,308	114,346

Part II of the ICI Waste Stream analyses is particularly informative for state efforts to promote the expansion of food waste diversion. While increasing the collection and diversion of residential food waste remains an important goal, the growth of food waste infrastructure will depend on the participation of commercial waste generators, supermarkets and restaurants in particular. Some supermarkets are already taking independent steps to increase their food diversion. Wal-Mart, Whole Foods, select Harris Teeter locations, and some niche food retailers are segregating and diverting large portions of their food waste. The EPA provides helpful diversion tools and priorities for these individual generators and communities at <http://www.epa.gov/osw/conserve/materials/organics/food/fd-res.htm>.

Helping large supermarket chains implement better segregation practices and encouraging them to increase food donation and use of composting alternatives is a useful first step in North Carolina. A great deal of potential exists for DENR to help statewide chains analyze and increase their diversion across-the-board. A similar strategy might also be applied to chain restaurants, whose small individual generators appear to create the bulk of food waste tonnage statewide.

While the collection of food waste in the commercial sector can help divert a substantial amount of material, DENR should also facilitate the growth of residential diversion programs. Food waste makes up at least 12 percent of MSW and, on average, each North Carolina household produces more than seven pounds of food waste a week. Local government food waste collection programs are being implemented in other parts of the United States, and DENR can employ funding and technical assistance resources to initiate those kinds of programs here. In the meantime, other proven methods of residential food waste diversion should also be encouraged. Over the last decade, through grants to local agencies, DENR has helped distribute more than 10,000 compost bins to residents across the state that are diverting food waste in their own backyards. By providing training and grant funding, DENR can help increase the practice of backyard composting. In addition, an increasing number of small-scale composters and food waste haulers are offering subscription pick-up service to households. These entrepreneurs should receive local and state support to succeed and grow.

Data from permitted composting facilities in North Carolina shows an upward trend in food waste collection. More than 60,000 tons of food waste was processed by permitted composting facilities, according to their FY 2010-11 annual permit reports. This figure includes material from retailers and institutions as well as material from food manufacturing companies, who are not included in this study's overall generation calculations. Using the assumption that five out every 1,000 households in North Carolina practice backyard composting, residents may be diverting as much as 2,000 tons per year of

food wastes. Finally, food charity programs divert a sizable portion of food from landfills. The Interfaith Food Shuttle in Raleigh, for example, diverts about 3,550 tons of material through its rescue program.

DENR should work to increase cooperation and matching of specific generators by county to the food waste infrastructure currently available, determining where infrastructure investment is most needed by geographic area. Using population percentages, the estimates from this study predict a per-county annual amount of food waste. Table 15 provides a rough idea of county level food waste generation in North Carolina.

Table 15: Amount of Food Waste Generated by County

County	Percent of North Carolina Population	Estimated Annual Tons Residential Food Waste	Estimated Annual Tons ICI Food Waste	Estimated Annual Tons MSW Food Waste
Alamance County	1.6%	10,689	9,038	17,657
Alexander County	0.4%	2,586	2,187	4,272
Alleghany County	0.1%	771	652	1,273
Anson County	0.3%	1,856	1,569	3,065
Ashe County	0.3%	1,893	1,600	3,127
Avery County	0.2%	1,225	1,036	2,024
Beaufort County	0.5%	3,326	2,812	5,493
Bertie County	0.2%	1,456	1,231	2,404
Bladen County	0.4%	2,436	2,059	4,023
Brunswick County	1.1%	7,677	6,491	12,682
Buncombe County	2.5%	16,835	14,234	27,809
Burke County	0.9%	6,339	5,360	10,471
Cabarrus County	1.9%	12,654	10,699	20,903
Caldwell County	0.9%	5,746	4,858	9,491
Camden County	0.1%	698	590	1,153
Carteret County	0.7%	4,698	3,972	7,761
Caswell County	0.2%	1,632	1,380	2,696
Catawba County	1.6%	10,751	9,091	17,760
Chatham County	0.7%	4,476	3,785	7,395

Cherokee County	0.3%	1,896	1,603	3,132
Chowan County	0.2%	1,036	876	1,711
Clay County	0.1%	737	623	1,217
Cleveland County	1.0%	6,798	5,748	11,230
Columbus County	0.6%	4,024	3,403	6,648
Craven County	1.1%	7,307	6,178	12,070
Cumberland County	3.4%	22,655	19,155	37,423
Currituck County	0.2%	1,670	1,412	2,759
Dare County	0.4%	2,392	2,023	3,952
Davidson County	1.7%	11,345	9,593	18,741
Davie County	0.4%	2,898	2,450	4,786
Duplin County	0.6%	4,152	3,511	6,859
Durham County	2.8%	19,064	16,119	31,492
Edgecombe County	0.6%	3,908	3,304	6,455
Forsyth County	3.7%	24,752	20,928	40,886
Franklin County	0.6%	4,263	3,605	7,043
Gaston County	2.1%	14,437	12,207	23,848
Gates County	0.1%	840	710	1,387
Graham County	0.1%	614	519	1,014
Granville County	0.6%	4,182	3,536	6,909
Greene County	0.2%	1,503	1,271	2,483
Guilford County	5.1%	34,537	29,202	57,051
Halifax County	0.6%	3,778	3,194	6,240
Harnett County	1.2%	8,316	7,031	13,737
Haywood County	0.6%	4,104	3,470	6,779
Henderson County	1.1%	7,526	6,363	12,432
Hertford County	0.3%	1,704	1,441	2,814
Hoke County	0.5%	3,436	2,905	5,676

Hyde County	0.1%	406	343	671
Iredell County	1.7%	11,241	9,504	18,569
Jackson County	0.4%	2,809	2,375	4,640
Johnston County	1.8%	12,035	10,176	19,881
Jones County	0.1%	699	591	1,154
Lee County	0.6%	4,097	3,464	6,768
Lenoir County	0.6%	4,138	3,499	6,835
Lincoln County	0.8%	5,504	4,654	9,092
McDowell County	0.5%	3,145	2,659	5,195
Macon County	0.4%	2,376	2,009	3,925
Madison County	0.2%	1,452	1,227	2,398
Martin County	0.3%	1,686	1,426	2,785
Mecklenburg County	9.8%	65,853	55,680	108,781
Mitchell County	0.2%	1,077	911	1,779
Montgomery County	0.3%	1,929	1,631	3,187
Moore County	0.9%	6,231	5,268	10,292
Nash County	1.0%	6,702	5,667	11,071
New Hanover County	2.1%	14,378	12,157	23,751
Northampton County	0.2%	1,527	1,291	2,522
Onslow County	1.9%	12,532	10,596	20,702
Orange County	1.4%	9,466	8,004	15,637
Pamlico County	0.1%	920	778	1,520
Pasquotank County	0.4%	2,838	2,399	4,688
Pender County	0.6%	3,724	3,148	6,151
Perquimans County	0.1%	940	795	1,554
Person County	0.4%	2,764	2,337	4,566
Pitt County	1.8%	11,934	10,090	19,713
Polk County	0.2%	1,412	1,194	2,333

Randolph County	1.5%	9,927	8,393	16,398
Richmond County	0.5%	3,250	2,748	5,369
Robeson County	1.4%	9,450	7,990	15,610
Rockingham County	1.0%	6,508	5,503	10,750
Rowan County	1.4%	9,624	8,138	15,898
Rutherford County	0.7%	4,710	3,982	7,780
Sampson County	0.7%	4,444	3,758	7,341
Scotland County	0.4%	2,501	2,114	4,131
Stanly County	0.6%	4,228	3,575	6,983
Stokes County	0.5%	3,294	2,785	5,442
Surry County	0.8%	5,140	4,346	8,491
Swain County	0.1%	979	828	1,618
Transylvania County	0.3%	2,289	1,935	3,780
Tyrrell County	0.0%	304	257	503
Union County	2.1%	14,327	12,114	23,667
Vance County	0.5%	3,159	2,671	5,219
Wake County	9.6%	64,836	54,820	107,100
Warren County	0.2%	1,455	1,230	2,403
Washington County	0.1%	905	765	1,494
Watauga County	0.5%	3,580	3,027	5,913
Wayne County	1.3%	8,626	7,293	14,248
Wilkes County	0.7%	4,810	4,067	7,946
Wilson County	0.8%	5,680	4,802	9,382
Yadkin County	0.4%	2,669	2,257	4,409
Yancey County	0.2%	1,234	1,044	2,039
		673,362	569,343	1,112,308

*In 2011 Chatham County reported 4,533 real tons of residential food waste.

** In 2011 Orange County reported 7,899 real tons of MSW food waste.

***In 2011 Wake County reported 95,703 real tons of MSW food waste.

Bibliographic Notes

Waste Characterization Studies

The 2009 *Illinois Commodity/Waste Generation and Characterization Study* reports 919,050 tons of food waste (14.6%) in the residential waste stream, 919,050 tons of food waste (12.2%) in the ICI waste stream, and 1,956,400 tons of MSW food waste landfilled in Illinois (Table 3-4). Residential waste is defined as, “garbage, general household, institutional and commercial waste, landscape waste and construction or demolition debris.” Our report removes about 4.3 million tons of C&D material, organic or otherwise, from the residential estimates.

The 2010 *Connecticut State-wide Solid Waste Composition and Characterization Study* estimates 183,112 tons (Table 8, pg 18) of residential, 138,369 tons (Table 9, pg 21) of ICI, and 321,481 tons (Table E.1, pg ES-3) of MSW food waste disposed of in Connecticut. MSW includes commercial, residential, self-hauled C&D, and self-hauled other sectors.

The 2008 *California Statewide Waste Characterization Study* reports 3,034,040 tons of residential, 3,032,805 tons of commercial, and 6,158,120 tons of MSW food waste disposed of in California. (Table 29, pg 53)

The 2009 *Washington Statewide Waste Characterization Study* reports that residential waste is 36.7% of total waste stream (Table 6, pg 9), 22.7% of residential waste is food (Table 13, pg 21). ICI waste is 43.7% of total waste stream (Table 6, pg 9), 22.3% of ICI waste is food (Table 11, pg 18). Therefore there is 414,878.82 tons of residential, 485,305.98 tons of ICI, and 916,320.00 tons (18.4%) (Table 8, pg 15) of MSW food waste disposed of in Washington.

The 2008 *Missouri Waste Composition Study* estimated 639,002 tons of food disposed of in landfills and transfer stations. (pg 40)

The 2009 *State Of Nebraska Waste Characterization Study* reports 1,342,000 tons of total MSW (pg 8-1), 46% of which is residential (pg 5-17), about 17% of which is disposed as food waste (Table 8.1, pg 8-2). 37% of MSW is commercial (pg 5-17), about 16% of which is food waste. Therefore there was 106,302.50 residential and 78,751.24 tons of commercial food waste disposed of in Nebraska.

The *Oregon Waste 2009/2010* presentation to the Association of Oregon Recyclers and the Oregon Waste composition data from 2009/2010 were used to determine the amounts in this report. 646,170 tons of residential waste was collected by Oregon waste trucks, 28.87%, or 186,549.28 tons, of which were food waste. 326,046 tons of commercial waste were collected, 25.15%, or 81,996 tons, of which were food. 2,596,340 tons of all substreams were collected, 16.99%, or 441,118.10, tons of which was food waste. (<http://www.deq.state.or.us/lq/sw/disposal/wastecompstudy2009.htm>, context for some of the data can also be found here <http://www.deq.state.or.us/lq/pubs/docs/sw/LegReport2010.pdf>)

The 2009 *Wisconsin State-Wide Waste Characterization Study* reports 251,423 tons of residential (Table 3-4, pg 3-8) and 239,546 (Table 3-9, pg 3-16) tons of ICI food waste landfilled in Wisconsin.

The 2005 *Georgia Statewide Waste characterization Study* states that there is a total of 10,037,540 tons of MSW disposed in the state (pg 2-5). It defaults to a national assumption of 40% residential and 40% commercial tonnage in MSW with a 20% margin of variance (pg2-8). At 40%, residential tonnage would be 4,015,016 and commercial tonnage would also be 4,015,016 tons. The report primarily studied percentage composition. 12% of Georgia's MSW is food waste (Table 4-3, pg 4-4), 13.4% of residential waste is food (Table 4-3, pg 4-10), 12.4% of commercial waste is food (Table 4-3, pg 4-10). Therefore, there is $10,037,540 * 12\% = 1,204,504.80$ tons of food waste in MSW, $4,015,016.00 * 13.40\% = 538,012.14$ tons of food waste in the residential stream, and $4,015,016.00 * 12.40\% = 497,861.98$ tons of food waste in the commercial stream in Georgia.

The 2011 Wake county Waste Characterization study states that the county's overall waste stream is composed of 15.1% food (Exhibit 2, pg 9). According to the county Waste Disposal Report for 2010/2011, Wake sent a total of 633,795.09 tons of waste to MSW landfills. Therefore, $15.1\% * 633,795.09 =$ about 95,703 tons of food in Wake county's waste stream.

The 2011 Wake County Waste Characterization study states that the county's overall waste stream is composed of 15.1% food (Exhibit 2, pg 9). According to the county Waste Disposal Report for 2010/2011, Wake County sent a total of 633,795.09 tons of waste to MSW landfills. Therefore, $15.1\% * 633,795.09 =$ about 95,703 tons of food in Wake County's waste stream.

The 2010 Orange County Waste characterization Study states that Food Waste makes up 16.7% of the municipal waste stream (Exhibit A-9, http://www.co.orange.nc.us/recycling/documents/WasteSort2010/Summary_by_geographic_area.pdf). According to the county Waste Disposal Report for 2010/2011, Orange County sent a total of 51,145.86 tons of waste to MSW landfills. Therefore, $16.7\% * 51,145.86 =$ about 8,541 tons of food in Orange County's waste stream

Other Citations

Residential Waste:

I. See Waste Characterization Studies

II. Visual copied from EPA-Food-Waste-Biogas-Economic-Model (2010), based on USDA 2007 data. See "Co-Digestion Economic Analysis Tool (CoEAT)" hosted by Pacific Southwest, EPA Region 9 <http://www.epa.gov/region9/organics/coeat/>

III. Jones, Timothy W. . PhD. "Using Contemporary Archaeology and Applied Anthropology to Understand Food Loss in the American Food System," Bureau of Applied Research in Anthropology." 2005. pg 2-3.

http://www.ce.cmu.edu/~gdrg/readings/2006/12/19/Jones_UsingContemporaryArchaeologyAndAppliedAnthropologyToUnderstandFoodLossInAmericanFoodSystem.pdf

Buzby, Jean C. , Hodan Farah Wells, Bruce Axtman, and Jana Mickey. "Supermarket Loss Estimates for Fresh Fruit, Vegetables, Meat, Poultry, and Seafood and Their Use in the ERS Loss-Adjusted Food Availability Data" Economic Research Service. United States Department of Agriculture. Economic Information Bulletin Number 44. March 2009. Pg 10, 13, 17.

IV. "Identification, Characterization, and Mapping of Food Waste and Food Waste Generators in Massachusetts," Draper/Lennon, Inc. Massachusetts Department of Environmental Protection Bureau of Waste Prevention. September 19, 2002 Table ES-1, pg2.

Generator Category	Minimum Size Included in MDEP Database, pg 4	Minimum Size Included in DENR Study	Source in DENR Study (Sources approximate MDEP's citations, pg 12)
Food manufacturers / processors	>=5 employees	>=5 employees	2010 County Business Patterns
Food wholesalers / distributors	>=5 employees	N/A	N/A
Hospitals	All identified inpatient establishments included	IBID	2010 County Business Patterns
Nursing homes	All identified establishments included	IBID	Nursing Home Directory, Medicare.gov/overview
Colleges, universities 101	All identified establishments included	IBID	
Independent schools, primary and/or secondary	Boarding schools only > 250 students	Boarding schools only	NC Division of Non-Public Education, Conventional Non-Public Boarding Schools Directory
Correctional facilities 17 All identified establishments included	All identified establishments included (state corrections system only, not including county and local jails)	IBID	National Institute of Corrections. Overview of Correctional System http://nicic.gov/StateStats/?st=NC
Resorts / conference properties	Banquet seating for >=250 guests	IBID	Estimate provided by NC Division of Tourism
Restaurants	>=10 employees and >=\$200,000 annual sales	>=10 employees	2010 County Business Patterns
Supermarkets, grocery stores	>\$1.5 million sales, or >15 employees (convenience stores excluded)	>=10 employees, (convenience Stores included)	2010 County Business Patterns

Commercial Waste:

(Part 2)

I. Data provided to the North Carolina Department of Energy and Natural Resources by state hauling company; June 14, 2012.

II. See Above

III. Data provided to the North Carolina Department of Energy and Natural Resources by county representative; 5/29/2012.

Municipal Solid Waste:

I. See Waste Characterization Studies

II. The 2010 EPA fact sheet is published by the Environmental Protection Agency of the United States Government. It was accessed via <http://www.epa.gov/osw/nonhaz/municipal/msw99.htm> on 04/05/2012.

North Carolina’s 2011 Solid Waste Management Annual Report states that 9,467,045 tons of MSW were landfilled in FY 2010-11. All solid waste reports are available at <http://portal.ncdenr.org/web/wm/sw/swmar>

Conclusion:

“About Us,” Inter-Faith Food Shuttle. Accessed via <http://www.foodshuttle.org/about-us> on 07/24/2012.

Appendix A

WRAP, a British nonprofit, conducts a variety of surveys and studies to characterize household food waste in the United Kingdom. The results from their studies and additional local authority surveys are consolidated in the 2009 report, “Household Food and Drink Waste in the UK.” The report determines that 330 kg of food and drink waste is generated per household per year (pg 29). The report states the average household size in England as 2.4 (pg 29). The estimate also includes measurement of drink waste, i.e. sewer measurements, but does not measure waste generated outside the home.

WRAP estimated weight of food waste per household per year in short tons	Average Household Size, North Carolina (2006-2010)	# of Households (2006-2010)	Total Annual Residential Food Waste
0.36	2.48	3,626,179	1,319,069

Source: “Household Food and Drink Waste in the UK.” WRAP – A World Without Waste. Nov 2009. ISBN: 1-84405-430-6